

## **Remarks**

### **The claimed invention**

The present invention includes a light-emitting device that includes a population of quantum dots (QDs) disposed in a host matrix. The QDs photoluminesce light in a color characteristic of their size, size distribution, and/or composition. The invention also includes a composition comprising a population of QDs disposed in a host matrix, and a method of producing light of a selected color by illuminating a population of QDs disposed in a host matrix.

### **Rejections under 35 U.S.C. § 102**

Claims 1-4, 7-9, 13, 14, 27, 28, 30, 31, 35-39, 44, 46-56, and 61-69 stand rejected under 35 U.S.C. § 102(b) as anticipated by Hakimi. This rejection is respectfully traversed for the reasons set forth below.

Independent claim 1, from which claims 2-4, 7-9, 13, and 14 depend, recites a primary light source and a population of QDs disposed in a host matrix. The matrix is in optical communication with the light source and is disposed so as to allow light to pass therethrough, thereby causing the QDs to photoluminesce.

Hakimi describes a quantum dot laser, in which quantum dots are irradiated by a pumping source such as an argon ion laser. Partially reflective mirrors largely contain the laser light within the lasing compartment so that a population inversion can be achieved, allowing the quantum dots to lase.

The laser system described by Hakimi does not “allow the light to pass” through the matrix in the sense of that phrase as recited in claim 1. The device of the present invention allows both primary and secondary light to freely pass through the matrix material and out of the device. In Hakimi, the light is contained by mirrors and must stay in the device for many “rebounds,” so that lasing can occur, rather than passing “through” the device as recited in claim 1. For at least this reason, Applicants respectfully submit that Hakimi does not anticipate claims 1-4, 7-9, 13, and 14. Reconsideration and withdrawal of the rejection is therefore requested.

Independent claim 27, from which claims 28, 30, 31, and 35 depend directly or indirectly, as amended herein, recites a population of QDs dispersed in a host matrix, where the QDs are selected to photoluminesce when irradiated by a primary light source. Independent claim 36, from which claims 37-39 and 44 depend directly or indirectly, as amended herein, recites a prepolymer composition, comprising a precursor material capable of being reacted to form a solid host matrix, and a population of QDs disposed in the precursor material.

Hakimi does not enable one of ordinary skill in the art to make a host matrix or prepolymer having QDs *dispersed* (i.e., distributed throughout the bulk without substantial flocculation) in a matrix. The entirety of Hakimi's disclosure of how the quantum dots are disposed in the matrix is the single statement, "Disposed in host material 12 are a multiplicity of quantum dots 14 made of cadmium selenide which fluoresces at 550 nm." (col. 3, lines 34-36) As discussed at length in the present application, the dispersal of QDs through a matrix without substantial flocculation requires significant attention to the chemistry of the surface layer of the dots (p. 15, lines 18-29; Examples). Thus, the very limited disclosure of Hakimi would not allow one of ordinary skill in the art to prepare a host matrix having a population of QDs dispersed therein, as recited in claim 27. Further, there is no discussion or suggestion whatsoever in Hakimi of a prepolymer, let alone a prepolymer having QDs dispersed therein, as recited in claim 36. For at least this reason, Applicants respectfully submit that Hakimi does not anticipate claims 27, 28, 30, 31, 35-39, and 44. Reconsideration and withdrawal of the rejection is therefore requested.

Independent claim 46, from which claims 47-56 and 61-69 depend directly or indirectly, recites a method of producing light of a desired color. The method includes providing a population of QDs having a desired size distribution and a surface adapted to allow dispersion in a host matrix, dispersion of these QDs in the host matrix, and illumination of the host matrix in order to allow the QDs to photoluminesce.

As a preliminary matter, Applicant respectfully disputes the Office Action's characterization of claims 62-67 as product-by-process claims. A product-by-process claim recites an apparatus or a composition of matter, but places limitations on how that apparatus or

composition may be produced. Claims 62-67 are all directed to *methods* of producing light, and each element of these claims is a *method* step. As such, the Office Action's invocation of case law relating to product-by-process claims does not apply to the presently pending claims.

As discussed above, Hakimi does not provide any disclosure of how to "disperse" QDs in a matrix, as recited in claim 46. For at least this reason, Applicant respectfully submits that Hakimi does not anticipate any of claims 46-56 or 61-69. In addition, Hakimi fails to disclose or suggest any of the limitations of many of the rejected dependent claims. For example, Hakimi does not disclose that the emitted light may comprise light from the primary source, as claimed in claims 48, 50, 51, 53, and 55. Further, Hakimi does not disclose even one precursor material having QDs dispersed therein, as claimed in claim 62, let alone multiple precursor materials as claimed in claims 63-67.

For at least the reasons set forth above, Applicants respectfully submit that Hakimi does not anticipate claims 46-56 or 61-69. Reconsideration and withdrawal of the rejection is therefore requested.

Claims 1-3, 6-8, 13-27, 30, 36, 37, and 46-55 stand rejected under 35 U.S.C. § 102(e) as anticipated by Soules. As a preliminary matter, Applicant notes that Soules issued from a continuation-in-part application that was filed after the priority date of the present application. However, the parent application of Soules, 09/019,647, was filed prior to the priority date of the present application. As of this writing, Applicants have not been able to obtain a copy of the priority application. Without conceding that either the priority application or the issued patent constitute prior art, Applicants present the following remarks regarding the disclosures of the issued patent.

Independent claim 1, from which claims 2, 3, 6-8, and 13 depend, independent claim 27, from which claim 30 depends, independent claim 36, from which claim 37 depends, and independent claim 46, from which claims 47-55 depend, are all described above.

Soules describes a light-emitting device including a blue LED, a polymer layer including embedded phosphors, and a clear polymer lens (Fig. 2). Disclosed potential phosphors include

YBO<sub>3</sub>:Ce<sup>3+</sup>, Tb<sup>3+</sup>; BaMgAl<sub>10</sub>O<sub>17</sub>:Eu<sup>2+</sup>, Mn<sup>2+</sup>; (Sr, Ca, Ba)(Al, Ga)<sub>2</sub>S<sub>4</sub>:Eu<sup>2+</sup>; Y<sub>2</sub>O<sub>2</sub>S:Eu<sup>3+</sup>, Bi<sup>3+</sup>; YVO<sub>4</sub>:Eu<sup>3+</sup>, Bi<sup>3+</sup>; SrS:Eu<sup>2+</sup>; SrY<sub>2</sub>S<sub>4</sub>:Eu<sup>2+</sup>; CaLa<sub>2</sub>S<sub>4</sub>:Ce<sup>3+</sup>; and (Ca, Sr)S:Eu<sup>2+</sup> (col 4, lines 25-31).

The phosphors described by Soules are not quantum dots, as that term is understood in the art. Quantum dots are nanocrystals that are sufficiently small that they exhibit measurable quantum confinement effects. In contrast, a phosphor is any material that exhibits phosphorescence: the emission of a photon as part of a relaxation of an electron from an excited to a ground state. The materials described in Soules are all known phosphorescent materials that do not rely on quantum confinement effects to produce light. There is no disclosure in Soules of any sort of quantum dot, as required by all of the currently pending claims. Thus, Applicant respectfully submits that none of the pending claims can be anticipated by Soules. Reconsideration and withdrawal of the rejection is therefore requested.

#### Rejections under 35 U.S.C. § 103

Claims 5, 10-12, 29, 32-34, 40-43, and 57-60 stand rejected under 35 U.S.C. § 103(a) as obvious over Hakimi in view of Bawendi. This rejection is respectfully traversed for the reasons set forth below.

Claims 5 and 10-12 depend directly or indirectly from claim 1, discussed above. These dependent claims recite coats on QDs which are incorporated into the device of claim 1.

As discussed above, Hakimi does not describe or suggest light passing through a matrix as recited by claim 1. This defect is not remedied by Bawendi, which does not describe a host matrix at all. In addition, neither Hakimi nor Bawendi describes the coats recited in claims 10-12, which comprise materials having an affinity for the host matrix. For at least these reasons, Applicants respectfully submit that claims 5 and 10-12 are not obvious over Hakimi in view of Bawendi. Reconsideration and withdrawal of the rejection is therefore respectfully requested.

Claims 29 and 32-34 depend directly or indirectly from claim 27, discussed above. These dependent claims recite coats on QDs which are incorporated into the composition of claim 27.

As discussed above, Hakimi does not enable one of ordinary skill in the art to make a population of QDs dispersed in a host matrix, as recited by claim 27 (amended). This defect is

not remedied by Bawendi, which does not describe a host matrix at all. In addition, neither Hakimi nor Bawendi describes the coats recited in claims 32-34, which comprise materials having an affinity for the host matrix. For at least these reasons, Applicants respectfully submit that claims 29 and 32-34 are not obvious over Hakimi in view of Bawendi. Reconsideration and withdrawal of the rejection is therefore respectfully requested.

Claims 40-43 depend directly or indirectly from claim 36, discussed above. These dependent claims recite coats on QDs which are incorporated into the prepolymer composition of claim 36.

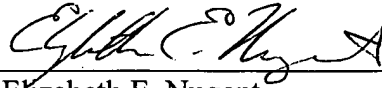
As discussed above, Hakimi does not enable one of ordinary skill in the art to make a population of QDs dispersed in a precursor material, as recited by claim 36 (amended). This defect is not remedied by Bawendi, which does not describe a precursor material at all. In addition, neither Hakimi nor Bawendi describes the coats recited in claims 41-43, which comprise materials having an affinity for the host matrix. For at least these reasons, Applicants respectfully submit that claims 40-43 are not obvious over Hakimi in view of Bawendi. Reconsideration and withdrawal of the rejection is therefore respectfully requested.

Claims 57-60 depend directly or indirectly from claim 46, discussed above. These dependent claims recite additional steps of depositing coats on QDs, which are dispersed in a host matrix as recited in claim 46.

As discussed above, Hakimi does not describe a method of dispersing a population of QDs in a host matrix, as recited by claim 46. This defect is not remedied by Bawendi, which does not describe a host matrix at all. In addition, neither Hakimi nor Bawendi describes the coats recited in claims 59 and 60, which comprise materials having an affinity for the host matrix. For at least these reasons, Applicants respectfully submit that claims 57-60 are not obvious over Hakimi in view of Bawendi. Reconsideration and withdrawal of the rejection is therefore respectfully requested.

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Respectfully submitted,



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